

Determination of the pressure relief valve for the vacuum vessel

Ch D - 02/15/02

Volume Vacuum Vessel

Assumption :

$$LH2 := 25 \text{ liter}$$

$$D1 := 15.624 \cdot \text{in}$$

$$D2 := 19.564 \cdot \text{in}$$

$$L1 := 26 \cdot \text{in}$$

$$L2 := 14 \cdot \text{in}$$

$$V1 := 3.14 \cdot L1 \cdot \frac{D1^2}{4}$$

$$V2 := 3.14 \cdot L2 \cdot \frac{D2^2}{4}$$

$$V1 = 81.645 \text{ liter}$$

$$V2 = 6.893 \times 10^7 \text{ mm}^3$$

$$V_{\text{total}} := V1 + V2$$

$$V_{\text{total}} = 150.576 \text{ liter}$$

$$\text{Ratio} := \frac{V_{\text{total}}}{LH2}$$

$$\text{Ratio} = 6.023$$

Surface Vacuum Vessel

$$S1 := 3.14 \cdot L1 \cdot D1$$

$$S2 := 3.14 \cdot L2 \cdot D2$$

$$S1 = 0.823 \text{ m}^2$$

$$S2 = 0.555 \text{ m}^2$$

$$S_{\text{total}} := S1 + S2$$

$$S_{\text{total}} = 1.378 \text{ m}^2$$

Estimation of the wetted area

Tune alpha==>

$$\alpha := 1.925 \cdot \text{rad}$$

Assumption : $R := \frac{(D1 + D2)}{4}$

$$\alpha = 110.294 \text{ deg}$$

$$b := R \cdot \alpha$$

$$b = 0.43 \text{ m}$$

$$h := R \cdot \left(1 - \cos\left(\frac{\alpha}{2}\right) \right)$$

$$h = 0.096 \text{ m}$$

$$s := 2 \cdot R \cdot \sin\left(\frac{\alpha}{2}\right)$$

$$s = 0.367 \text{ m}$$

$$A := \frac{h}{6 \cdot s} \cdot (3 \cdot h^2 + 4 \cdot s^2)$$

$$A = 0.025 \text{ m}^2$$

==>define alpha with (1)=VtotalH2=25liter

$$A \cdot (L1 + L2) = 25.001 \text{ liter}$$

Wetted area : WAH2

$$WAH2 := \alpha \cdot R \cdot (L1 + L2)$$

$$WAH2 = 4.37 \times 10^3 \text{ cm}^2$$

Flux from wetted area to VV surf :(20W/cm^2)

$$q := 20 \cdot \frac{\text{watt}}{\text{cm}^2}$$

$$Q := q \cdot WAH2$$

$$Q = 8.74 \times 10^4 \text{ W}$$

Mass flow of LH2

$$\text{LatentheatH2} := 443 \cdot \frac{\text{joule}}{10^{-3} \text{kg}}$$

$$mH2 := \frac{Q}{\text{LatentheatH2}}$$

$$mH2 = 0.197 \frac{\text{kg}}{\text{sec}}$$

$$SCFM := 3.16 \cdot mH2 \frac{\text{hr}}{\text{lb}}$$

$$mH2 = 1.566 \times 10^3 \frac{\text{lb}}{\text{hr}}$$

$$SCFM = 4.948 \times 10^3$$

Calculation of required area of the rupture disk

$$k := 1.4$$

$$Pe := 14.7 \cdot \frac{\text{lb}}{\text{in}^2}$$

$$Po := 25 \cdot \frac{\text{lb}}{\text{in}^2}$$

$$K := 0.62 \quad \text{Coefficient (FIKE TB 8102)}$$

$$MH2 := 2 \quad \text{Molecular weight of Hydrogen}$$

$$T := 60 \quad \text{Gas temperature in farenheit} \quad 60 + 460 = 520$$

$$C1 := 0.0792 \quad \text{Cst (FIKE TB 8102, table 1)}$$

$$a \quad \text{Required rupture disk area}$$

$$A \quad \text{Parallel plate flow area}$$

$$\text{With :} \quad mH2 = 0.435 \frac{\text{lb}}{\text{sec}}$$

$$\frac{Pe}{Po} = 0.588 \quad \text{is > to 0.528 therefore the flow is subsonic}$$

$$a := \frac{mH2}{K \cdot C1 \cdot Po} \left[\frac{(T + 460)}{MH2} \right]^{0.5}$$

$$a = 5.713 \frac{\text{in}^2}{\text{sec}}$$

$$Da := \left(4 \cdot \frac{a \cdot \text{sec}}{3.14} \right)^{0.5}$$

The minimum rupture disk area is therefore 5.72 in²

Da = 2.698 in

Parallel plate relief flow area

$$D := 3 \cdot \text{in} \quad \text{Parallel plate relief diameter}$$

$$A := 3.14 \cdot \frac{D^2}{4}$$

$$A = 7.065 \text{ in}^2$$